

What is claimed is:

1           1.     An implanted device-implemented method of detecting and monitoring  
2 congestive heart failure in a patient, which comprises the steps of:

3           performing ongoing measurements of changes in local impedance of a portion of the  
4 patient's body between at least two electrodes on the exterior of the implanted device, said  
5 changes representing ventilation of the patient, including  
6           measuring the patient's respiratory rate and respiratory amplitude.

1           2.     The implanted device-implemented method of claim 1, including:  
2           controlling the rate of a rate adaptive cardiac pacemaker, using the patient's  
3 ventilation represented by the measured changes in local impedance.

1           3.     The implanted device-implemented method of claim 1, including:  
2           detecting the cardiopulmonary status of the patient, using the patient's ventilation  
3 represented by the measured changes in local impedance.

1           4.     The implanted device-implemented method of claim 1, including:  
2           deriving a signal from the measured changes in local impedance that reflects  
3 congestion in heart failure patients.

1           5.     The implanted device-implemented method of claim 1, including:  
2           deriving both the patient's ventilation and DC impedance from the measured changes  
3 in local impedance, from which to detect an early stage of lung congestion of the patient.

1           6.     A method of early detection of pulmonary congestion in a patient, comprising:  
2           subcutaneously implanting an impedance monitoring device at a location on the  
3 patient's thorax at the lower part of the lungs constituting a site where initial accumulation of  
4 fluid occurs in the lungs, and

5 monitoring impedance changes at said location to detect pulmonary congestion.

1 7. A method of monitoring the cardiopulmonary status of a patient, comprising:  
2 detecting the patient's intrinsic heart activity,  
3 analyzing and storing the analysis of the detected intrinsic heart activity,  
4 evaluating a pattern of the patient's intrinsic heart activity derived from said analysis,  
5 and  
6 measuring and evaluating impedance at a selected site on the patient's body, and using  
7 said impedance evaluation together with said intrinsic heart activity pattern evaluation to  
8 derive information representing the cardiopulmonary status of the patient.

1 8. A method of detecting pulmonary congestion in a patient, comprising:  
2 implanting a subcutaneous impedance measuring device with electrodes connected  
3 thereto, and  
4 positioning said electrodes to measure impedance on the lower left side of the patient's  
5 lungs.

1 9. A body-implantable device adapted to detect and monitor congestive heart  
2 failure in a patient, comprising a circuit module coupled to plural surface electrodes of the  
3 device arranged and adapted, when the device is implanted, for contacting tissue in a portion  
4 of the patient's body generally occupied by the lungs, to monitor changes in local impedance  
5 of said body portion, and to detect the patient's EKG.

1 10. The body-implantable device of claim 9, wherein said circuit module utilizes at  
2 least two of said electrodes to both monitor said changes in local impedance and detect the  
3 patient's EKG.

1 11. The body-implantable device of claim 9, wherein said circuit module includes  
2 an accelerometer within said device.

1           **12.**    The body-implantable device of claim 9, wherein said device is adapted to be  
2 implanted subcutaneously.

1           **13.**    The body-implantable device of claim 9, wherein said circuit module includes  
2 a patient alert function.

1           **14.**    The body-implantable device of claim 9, wherein said circuit module includes  
2 means for telemetry communication with one or more control units external to the patient's  
3 body.

1           **15.**    A body-implantable device, comprising apparatus for measuring a patient's  
2 subcutaneous impedance at a location on the patient's body where the measured impedance  
3 has a linear correlation with the patient's cardiac output, and for monitoring a decrease in  
4 impedance baseline value to indicate cardiopulmonary status of the patient.

1           **16.**    A medical device adapted for subcutaneous implant in a patient to monitor  
2 cardiopulmonary status of the patient, comprising:

3           a first subsystem to detect the patient's intrinsic heart activity,  
4           a second subsystem to analyze and store the intrinsic heart activity,  
5           a third subsystem to evaluate a physical activity pattern of the patient generated by a  
6 mechanical-electrical converter,

7           a fourth subsystem to analyze and store the physical activity pattern,  
8           a fifth subsystem to measure and evaluate impedance at a local implant site of said  
9 device, and

10          a sixth subsystem to analyze and store said impedance, and to derive from the  
11 functions of the first, second, third, fourth, fifth and sixth subsystems information  
12 representing the cardio-pulmonary status of the patient.

1       **17.**     A medical device adapted for subcutaneous implant in a patient to evaluate  
2 cardiopulmonary status of the patient, comprising:

3             detection apparatus responsive to the heart rate/activity pattern of the patient and the  
4 impedance between a pair of electrodes contacting subcutaneous tissue at opposite sides of a  
5 lung of the patient, for performing said evaluation, and

6             evaluation apparatus for evaluating the trend of said heart rate/activity pattern and said  
7 impedance against one another, over a selected period of time.

1       **18.**     A device adapted to be implanted in a patient, comprising:

2             a housing for said device,

3             said device having electrodes on a surface of said housing constituting the only  
4 electrodes of said device, for detecting local impedance changes therebetween and locally  
5 derived EKG after said device is implanted in the patient, and

6             said housing incorporating a mechano-electrical converting element therein for  
7 responding to the status of physical activity of the patient.

1       **19.**     The device of claim 18, including an electronic module in said housing to  
2 determine from information derived from said impedance changes, said EKG and said status  
3 of physical activity, the status of congestive heart failure of the patient.

1       **20.**     The device of claim 18, including an electronic module in said housing to  
2 determine from information derived from said impedance changes, said EKG and said status  
3 of physical activity, the need for increasing or decreasing the heart rate of the patient.

1       **21.**     The device of claim 18, including an electronic module in said housing to  
2 determine from information derived from said impedance changes, said EKG and said status  
3 of physical activity, the occurrence of potentially lethal arrhythmias of the patient.

1           **22.**     The device of claim **18**, wherein said mechano-electrical converting element is  
2     an accelerometer.

1           **23.**     In a rate adaptive cardiac pacemaker adapted to be implanted in a patient's  
2     body, an improvement comprising:  
3           electrodes situated on one of a housing and a header of the pacemaker, and  
4           an electronic module for measuring impedance changes at said electrodes when the  
5     pacemaker is implanted, to control the pacing rate generated by the pacemaker.

1           **24.**     The device of claim **23**, including  
2     an accelerometer for detecting status of physical activity of the patient to assist in  
3     adjusting the pacing rate of the pacemaker.